clusions. Again, Prof. Ercolani says of Bischoff, whose views respecting the maternal and the placental conjunction he had vigorously combated, "With a generosity rather unique than rare, valuable material for study was placed at my disposal by the distinguished professors—Bischoff and Milne Edwards."

The text is handsomely and abundantly illustrated by means of an atlas of ten quarto plates, engraved by Bettini, and reproduced by the heliotype process.

Dr. Marcy has placed the profession under obligation for the admirable manner in which he has accomplished his task. It has been very evidently a labor of love. He well writes, "By these researches is opened an almost unexplored field in the pathology of gestation, and this, too, is essentially the medical and more practical view of the subject. In the abnormal development of the placenta, and in the modifications of the nutrition of the fœtus will be found causes hitherto unknown of embryonic disease and arrest of intra-uterine life." This is the use which the profession will make of this addition to its literature. Let us glance once more at Prof. Ercolani's text for the spirit which actuated him in securing this contribution so fertile in its suggestion of "diseased action." A spirit we fear that is but little acknowledged in this age of *practical* medicine. Let the student who thinks that everything that is not practical is not worth knowing ponder over these words, coming as they do from one who has solved the problem of the structure of the placenta.

> "With reverence," says our author, "do I recall the honoured memory of Filippo Ingrassia, who, in the classic land which was the cradle of the revival of letters, eulogized at the close of the sixteenth century the fruitful union of human and veterinary medical science in his famous oration, published in 1568, entitled 'Quod Medicina Veterinaria formaliter una eademque sit, cum Nobiliore Hominis Medicina.' At a period so remote from our own, and when veterinarians were only poor farriers, holding a very humble position compared with those skilled in human surgery, this was the happy intuition of a noble mind, which boldly outrun the times, sowing the seed of that entire revolution which after three centuries comparative and experimental pathology have introduced into all medical instruction. . . . Comparative pathology will make its way among those who cultivate medical science throughout the civilized world. . . . If I shall be successful [in elucidating the structure of the placenta] the merit will not belong to me, but to the university in which I was educated in medical knowledge, where my illustrious master learnedly explained the pregnant teaching left us by Ingrassia, and to my having pursued in the study of the human placenta the method adopted by Fabricius, of Acquapendente, three centuries ago."

H. A.

ART. XXIII.—*A Text-book of the Physiological Chemistry of the Animal Body, Including an Account of the Chemical Changes occurring in Disease.* By ARTHUR GAMGEE, M.D., F.R.S., Professor in Victoria University, Manchester; Brackenbury Professor of Physiology in Owen's Coll. Vol. 1. 8vo. pp. xix., 485. London; Macmillan &. Co., 1880.

IN taking up a work like the present one, replete with all the attractions of the latest scientific research in its own peculiar field, the reader who can look back over a quarter of a century's experience, cannot fail to be reminded of the astonishing progress that has been made in the department of Physiological Chemistry. Indeed it may be affirmed that chemistry itself, as a science, has been almost metamorphosed within this period; and physiology has not been behindhand in its own important developments. It is certainly within the bounds of truth to assert that Physiological Chemistry, as a science, was unknown fifty years ago. Those are yet living who can remember being taught that the functions of the animal body, as well as the various changes in its solids and fluids, are due exclusively to, what was then vaguely termed, *the vital force;* the idea of chemistry or physics being at all concerned was hardly dreamed of. How different is the experience of the student of the present day! Now, the very foundation of physiological knowledge is laid, so to speak, in chemical facts and doctrines; and these, moreover, must be diligently worked out by him in the laboratory, or received as the results of the investigations of others.

The author of the present treatise needs no introduction to the American reader. He has been long recognized as an authority in this, as well as in other departments of medical science. We have now before us, as the result of his careful and laborious researches, the first volume of "The Physiological Chemistry of the Animal Body;" "comprising the chemical composition of, and the chemical processes relating to, the elementary tissues of the body; including the blood, lymph, and chyle." The chemistry of the "Animal Functions" is reserved for the second volume, which the author promises to give us within a year.

We will briefly lay before the reader a summary of Volume I., premising that the author does not by any means confine himself to a mere chemical history of the elementary solids and fluids of the body; but he very wisely, we think, prefaces this with a brief description of their anatomical and physiological properties, by which he secures the interest of his readers in what might otherwise prove only a dry and uninteresting detail.

He commences, as is customary, with the chemistry of the proteids, albumin, fibrin, casein, the peptones, etc.; first giving their general characters, their origin, physiological relations, and their transformations or metabolism. Their method of separation from other bodies with which they may be associated, by the process of dialysis, as likewise the mode of their examination by polarized light, is described and accurately figured.

The metabolism of the proteids has afforded a wide and tempting field for speculative research, especially to the transcendental German mind. When we recall the prodigious number of the products of their decomposition through the agency of water, heat, putrefaction, the action of the strong mineral acids and alkalies—such as leucine, tyrosine, butyric, valeric and caproic acids, lactic acid, aspartic and glutamic acids, benzine, aniline, phenol, etc. etc.—we might expect that theories would not be wanting to explain and illustrate the exact manner in which these various transformations occur. Of course, in the metabolism of such complex bodies, where merely the addition of subtraction of an atom or two of oxygen, or even the simple alteration in the arrangement of the molecules, will result in the production of a new body,—just as a new form results from every turn of the kaleidoscope,—almost any theory may appear to be plausible, although it may be far from being the correct one. Fortunately for science, the theory is comparatively of little value, provided the facts be proven.

As regards the multiform products of the decomposition of the proteids, we are forced to agree with the author, that "although the progress of organic chemistry has been great, and our knowledge of the constitution of bodies has been wonderfully increased, we are yet far from being able to unravel the constitution of such complex bodies as the proteids." We know that in the animal body the ultimate results of their oxidation are urea, carbonic acid and water, but what exactly are the intermediate metamorphoses—the results of the various chemical twistings and turnings—we can only partially make out. It is, however, certain that in these intermediate changes, substances destitute of nitrogen, such as the carbohydrates, and also fat are produced. But how limited are the resources of the chemist of the present day, with all his boasted knowledge in his attempt to imitate any of these processes which are incessantly occurring in the animal economy! As the author truly observes, "no one has given valid proof of having, by an artificial oxidation, obtained urea."

As might have been expected from the importance of the subject, the author devotes a considerable space to the *Blood.* The proper method of collecting blood for examination from a living animal is described in detail, and a figure of the apparatus given; and the author takes occasion to recommend his method of very completely anæsthetizing dogs for experimental purposes, by first administering, hypodermically, two grains of meconate of morphia, and after the lapse of half an hour when complete narcotism is produced, to follow with the chloroform inhalation; by which means the anæsthesia may be maintained with great ease for a considerable time. The *specific gravity* of human blood is given at 1055 (average): that of dog's blood at 1060; and that of rabbit's blood 1047 (average).

The time at which *coagulation* takes place varies in different animals, according to the author, and is in the following order, beginning with the most rapid: rabbit, sheep, dog, human, ox, horse. It commences in men within four minutes after being drawn, and is completed within twelve minutes. In women, the process is more rapid, by one to three minutes. The circumstances which retard and accelerate coagulation, and the methods of procuring pure liquor sanguinis or plasma are carefully described; as is also Ranier's mode of procedure for exhibiting the formation of fibrin in blood under the microscope.

The *theories of the coagulation of the blood* are given in considerable detail, the researches of A. Schmidt and Hammarsten being particularly dwelt upon, as affording the latest results of experimental investigation. According to these authorities, there exist in the blood at least two proteid bodies named respectively *fibrinogen* and *paraglobulin* (serum-globulin or fibro-plastic substance). These bodies are probably the precursors of fibrin in the process of coagulation. The old doctrine that the cause of the coagulation of blood is owing to an inherent property in the fibrin to coagulate has been materially modified by modern observers. In 1831, Dr. Buchanan, of Glasgow, discovered that the addition of washed blood-clot to the serous fluid of the pericardium, the pleura, or of a hydrocele would produce a coagulum similar to that which separated spontaneously from blood. He believed that fibrin was not disposed to coagulate spontaneously, but only when under the influence of the washed blood-clot,—very much as milk is coagulated by rennet. Moreover, he found that the particular active element of the blood-clot was the colourless corpuscles. The researches of A. Schmidt, of Dorpat, at a still later period, advanced our knowledge considerably farther. This investigator was enabled to isolate the two proteid bodies, fibrinogen and paraglobulin, both of which are fibrin generators, but (as his later researches showed) dependent for their action upon the presence of a third body—a ferment, under whose specific influence the other two bodies reacted to produce fibrin. An analogy will immediately be suggested to the chemist in the case of amygdalin and emulsin, in the bitter almond, reacting with water to evolve hydrocyanic acid and the oil of bitter almonds. This fibrin ferment of Schmidt appears to be intrinsically connected with the colourless corpuscles of the blood.

The author details the methods of preparing these three interesting substances from blood, and describes their respective properties—physical and chemical. The important physiological question—why the blood does not coagulate in the living body—he answers somewhat vaguely, we think, by saying that it "is probably connected with a persistence in an intact condition of the colourless cells, or rather of those cells in which the fibrin ferment originates, and not as might have been supposed, upon the destruction of the fibrin ferment by the vascular walls at the moment of its liberation." As the conclusion of the whole matter, although much interesting light has been shed upon the *manner* in which the coagulation of blood takes place, we are forced to admit that nothing has been shown to disprove the doctrine of the spontaneous coagulation of fibrin, *when once that substance is actually formed.*

The two important proteids of the serum are *serum globulin* (paraglobulin) and *serum albumin.* The former of these has already been alluded to. According to Hammersten, the relative proportion of these two ingredients of serum varies remarkably in different animals, man included. In the horse (in 100 parts of serum) the serum globulin amounts to 4.565; the serum albumin to 2.677, the proportions being 1 to 0.591. In the ox, the proportion is 1 to 0.842. In man the proportion is 1 to 1.511 (3.103 of serum globulin to 4.516 of serum albumin). In the rabbit, the proportion is 1 to 2.5.

The various methods of obtaining pure serum albumin, together with its chemical reactions, are accurately described. The conclusion is also arrived at that the peptones, which are found so abundantly in the alimentary canal as the results of digestion, "cannot be demonstrated as such even in the blood of the portal vein, taken whilst absorption is progressing."

The *extractive matters* of the plasma and serum include a number of substances which are extracted by means of the different menstrua, alcohol especially. These bodies, although they exist in comparatively small quantities in the blood, yet play a most important part in the physiology of the living organism. They include fats, sugar, urea and uric acid, creatin and creatinin, cholesterin, etc. The description of these substances the author very properly reserves for Volume II., when he comes to treat of the various functions of the body, in connection with which they would naturally be formed,—*e. g.*, fats under the head of digestion; sugar under that of the liver; urea and uric acid under that of the kidney; creatin and creatinin in connection with muscle, and so on.

As regards the *salts* of the plasma and serum, the only points of special interest to notice are: 1. The serum contains a somewhat smaller proportion of inorganic salts than the liquor sanguinis, some being carried down with the fibrin when it separates. 2. The amount of inorganic matter left by cautious incineration is from 0.7 to 0.9 per cent. 3. The ash consists of (*a*) sodium chloride, the principal ingredient (61 to 65.2 per cent.); (*b*) sodium carbonate (about 29 per cent.); (*c*) potassium chloride (about 4 per cent.); (*d*) still smaller quantities of phosphates of sodium, magnesium, and calcium, together with potassium sulphate. But the precise mode in which the phosphoric acid exists in the liquids seems to be yet an open question. The experiments of Pribram and Gerlach go to show that "serum contains a much smaller quantity of phosphoric acid than is present in its ash ; and that the greater part of the phosphoric acid in the latter is derived from an organic compound soluble in alcohol."

The sections on the *blood corpuscles* are replete with interesting information, both physiological and chemical. They include the consideration of their structure, size, the proper mode of their microscopic observation and enumeration, and the methods of their chemical analysis. The name at present given to the true blood-colouring matter is *oxy-hæmoglobin*, in place of the old term *hæmatin;* the latter is now known to be merely a product of the decomposition of the former.

Oxy-hæmoglobin constitutes the bulk of the red blood-corpuscles; it may be procured directly from the latter or from the blood clot, in the crystalline form. It is obtained much more readily from the blood of certain animals than from others—that of the rat yielding the crystals with greatest facility. Quite a number of manipulations are given by the author, which need not be detailed here. The empirical formula for oxy-hæmoglobin, as given by Preyer, and deduced from analyses of Hoppe-Seyler and C. Schmidt, is $C_{600}H_{960}N_{154}FeS_3O_{179}$.

The following is a brief summary of its more important physical and chemical properties: As obtained from the blood of man and of the majority of the lower animals, oxy-hæmoglobin crystallizes in prisms or rhombic plates of a fine red colour. That of the squirrel crystallizes in hexagonal plates ; that of the guinea-pig in tetrahedral crystals. It differs much in solubility in water, as obtained from different animals ; that of the bullock and pig is very soluble, whilst that procured from the guinea-pig is much less so. It is very soluble in weak alkaline solutions ; an excess of alkali soon induces decomposition. Acids and salts decompose it, with the formation of hæmatin. It is precipitated by alcohol with decomposition, but by potassium carbonate, at a low temperature, without decomposition.

It is, however, in the optical properties of oxy-hæmoglobin, as exhibited by the spectroscope, that medical and medico-legal interest chiefly centres. The simple fact that the spectroscopic examination of blood will exhibit certain well-marked absorption bands in the spectrum has been known since 1864. The researches of Mr. Sorby and Prof. Stokes especially have made us familiar with this method of detecting the presence of minute quantities of blood; so that the spectroscope has now become a most valuable corroborative test for blood stains in criminal trials. Stokes discovered that when diluted blood was treated with certain reducing agents, the colour of the liquid was changed from a red to a brown, and the spectrum was also altered so as to present a single broad absorption band instead of the double band, which had previously been produced in the green space by the unchanged oxy-hæmoglobin. This constitutes the spectrum of *reduced hæmoglobin.* From these experiments Stokes concluded that the colouring matter of blood may exist in two conditions of oxidation, distinguishable by the action of the spectrum, and that it may be made to pass from the more to the less oxidized state by reducing agents, and recover its oxygen again by absorption from the atmosphere. This, then, is the fundamental idea in relation to the spectrum-analysis of blood—the effect produced by deoxidation and by subsequent oxidation. Different methods of reducing oxy-hæmoglobin to hæmoglobin are described by the author, which space will not permit us to give here.

The interesting chemical fact is alluded to that "where diluted blood is dropped upon a filter-paper, which has been moistened with tincture of guaiacum and then dried spontaneously with air, a blue ring forms at the edge of the drop." "This reaction is not produced by all specimens of tincture of guaiacum. The bluing of the resin of guaiacum is due to its oxidation, and is also observed when ozone acts upon it, but not when common oxygen does so." When the oxy-hæmoglobin is deoxidized it no longer possesses the power of bluing guaiacum, but if brought into contact with atmospheric oxygen, it immediately recovers it.

Now, just here, it is important for the medico-legal student especially, to understand the precise value of the so-called *guaiacum test* for blood. According to Dr. Day, of Australia, and verified by the late Prof. Taylor, of London, the red colouring matter of blood, never *immediately* changes the colour of the tincture of guaiacum, unless in the presence of peroxide of hydrogen (antozone). No value is to be placed on any change of colour which requires any considerable length of time for its production. It is true that the guaiacum may become blue-coloured after *long* exposure to the air by oxidation; but when a fragment of blood, however small or however old, is brought into contact with fresh tincture of guaiacum, together with the ethereal solution of peroxide of hydrogen (ozonized ether), the characteristic blue colour is *immediately* struck. Furthermore, no other red colouring matter has been found to produce this bluing of guaiacum in the presence of peroxide hydrogen. The very essence of the test, so to speak, consists in the *rapid* appearance of the blue colour, under the combined influence of the two above-mentioned reagents upon the blood stain.

It is now admitted by physiologists that the *iron* of the blood exists exclusively in the oxy-hæmoglobin of the red corpuscles. According to Preyer, 100 grammes of blood contain the following properties of iron in the corresponding amount of colouring matter, in a healthy man :—

	Hæmoglobin.	Iron.
Minimum	12.09 grms.	0.0508 grm.
Maximum	15.07 "	0.063 "
Average in 11 cases . . .	13.45 "	0.056 "

In a healthy woman :—

	Hæmoglobin.	Iron.
Minimum	11.57 grms.	0.048 grm.
Maximum	13 69 "	0.057 "

One hundred parts of dry crystallized oxy-hæmoglobin contains 0.42 parts of iron (Preyer).

Among the products of the decomposition of oxy-hæmoglobin, particularly by the agency of acids and acid salts, the most interesting are *hæmatin* and an intermediate body termed *methæmoglobin*. We can only offer a few remarks in connection with hæmatin. This substance may be obtained by the action of acetic acid on blood, and then shaking it with ether, which dissolves out the colouring matter. It can only be procured pure from crystallized hydrochlorate of hæmatin (hæmin). As thus prepared, it has a blue-black colour and metallic lustre; it is insoluble in water, alcohol, and ether; easily soluble in dilute alkaline solutions; insoluble in dilute acids. It contains, according to Hoppe-Seyler, 8.82 per cent. of iron. This large percentage of iron is to be explained from the circumstance that the whole of the iron belonging to oxy-hæmoglobin is in reality attached to the hæmatin, which is only one of the constituents of the former. It may be heated to 180° C. without decomposition; at a higher temperature it burns, evolving hydrocyanic acid, and leaving an ash which consists of 12.6 per cent. of pure oxide of iron. The empirical formula for hæmatin is: $C_{68}H_{70}N_8Fe_2O_{10}$. As before mentioned, when the oxy-hæmoglobin of the blood has by long exposure to the air, or otherwise, been transformed into hæmatin, the characteristic change is produced in the absorption bands of the spectrum.

If a drop or two of blood be boiled with glacial acetic acid, the colour changes to brown, and on evaporation, prismatic crystals are yielded of a dark brown colour. They are sometimes in the form of rhombic plates, arranged in radiating bundles; they constitute what have been usually termed "blood crystals." Such crystals may be obtained from any blood stain on clothes by cutting out the stained tissue and heating it with glacial acetic acid, taking care to add a small crystal of sodium chloride. The evaporated residue contains the crystals. There is some difference of opinion as to the precise composition of hæmatin. Thudichum says that it contains no chlorine: he regards hæmin to be nothing more than crystallized hæmatin. Hoppe-Seyler asserts that he never obtained hæmin crystals that were free from chlorine, which agrees with the original statements of Teichmann on their composition.

Passing over the sections on the *white blood-corpuscles*, and the various coloured corpuscles of certain invertebrata, we come to the chapter on "The Changes which the Blood undergoes in Disease," a subject which has always afforded a most interesting field for physiological and pathological research. There is abundant proof of the fact that considerable variation may occur in the proportion of some of the principal constituents of the blood within the bounds of health; and also that the loss of blood by hemorrhage will rapidly influence the composition of that which remains in the system. The variation in the quantity of the water is the most marked change.

There is nothing especially new in the enumeration of the various alterations of the blood in connection with different diseases. The author gives us the results of the recent investigations of the most trustworthy experimenters. The amount of hæmoglobin in health is proportional to the number of corpuscles. This is not, however, the case in disease (anæmia). As regards the fibrin, while, of course, admitting its well-known increase in inflammations—even up to 10 parts in 1000 of blood—the author is disposed to attribute their increase to "the proliferation of cellular elements which accompanies the process of inflammation, which will add to the number of colourless cells of the blood, and to the amount of serum-globulin which will be available in the process of coagulation."

The *serum-albumin* (av. 80 in 1000) increases in cholera, and after the use of hydragogue cathartics (C. Schmidt). It diminishes notably in "Bright's disease, anæmia, scurvy, dysentery, and generally in chronic disorders, which impair the general nutrition." The *sugar*, of course, is increased in diabetes. The amount of *urea* is largely increased in Bright's disease, in cholera, and yellow fever. *Uric acid* is remarkably increased in gout, but not in rheumatism. One or two diseases require a separate passing notice in this connection. In *anæmia*, it might have been supposed that the amount of loss of the hæmoglobin would correspond with the loss of the red corpuscles; but this is shown not to be the case, for the reason that the composition of the corpuscles is liable to vary in disease, as was first demonstrated by Schmidt in the case of cholera; more recently by Hayem and Malassez, who have shown "that in the various forms of anæmia the anatomical characters of the red corpuscles are affected." As a summary of the results of these recent investigations, we may say that these variations affect the *size*, *number*, *form*, and *coloration* of the corpuscles. Thus, according to Hayem, three different sizes of red corpuscles may be observed in healthy blood, which he classifies as *large*, *medium*, and *small*, the large constituting about 12 parts in the 100, the medium about 75 parts, and the smaller about 12 parts. In anæmia the blood contains *a large excess of small corpuscles*, and this diminution of size refers not only to their diameter, but to their whole volume. Thus, in very pronounced cases of anæmia, in consequence of this decrease in their size, 100 corpuscles may correspond to only 80, or even 65 healthy ones. Again, in anæmia, although there is a marked diminution in the *number* of the red corpuscles, this is not invariably the case. The *form* of the corpuscles also undergoes a change in anæmia, "seemingly dependent upon a diminished consistence, and which chiefly affects the medium or small corpuscles, which often assume an elongated oval form." But the most important change in anæmic blood is connected with its *colour*, the pale tint resulting from a most notable loss of hæmoglobin. In the most intense cases of this disorder, the decrease of hæmoglobin has been known to reach the enormous amount of seven-eighths of the normal quantity. In moderate cases, the loss may amount to one-half to three-fourths. The above results throw considerable light on the true pathology of anæmia. The remarkable effects of iron in restoring the lost colouring matter of the blood, so well known, are amply confirmed by the author's tabular statements.

In *leucocythæmia* (leukæmia) there is an enormous increase of the white corpuscles, so that their number "may amount to one-sixth, or, it is said, even one-third the number of the coloured corpuscles. Usually, the colourless corpuscles do not differ in shape and size from those in normal blood, though in certain cases they appear to be smaller in size."

Gout affords a notable example of a disease in which a change in the blood composition plays a conspicuous part. In 1848 Garrod discovered that during the course of gout, the blood invariably contains an excess of *uric acid*. This accumulation is probably owing to its non-elimination by the kidneys, seeing that "whilst the attack of gout is at its height, though the relative proportion of uric acid in the urine may be high, and an actual spontaneous separation of it often occurs after emission, the actual amount excreted is usually below the normal." This retention of uric acid in the blood is doubtless connected with the kidney affection, which almost always accompanies gout. Moreover, in gout the blood, according to Garrod, contains oxalic acid, and probably also an excess of urea.

The chief chemical and pathological distinction between gout and *rheumatism*, according to the author, is that in the latter disorder there is no excess of uric acid in the blood, and in the majority of cases, likewise an absence of lesions of the kidney. The most marked change consists in a considerable increase in fibrin.

In subacute rheumatism, and in so-called rheumatic gout (rheumatoid arthritis), "there are no constant changes in the composition of the blood." A most important difference between it and true gout being that in the former disease there is "no tendency to the accumulation of uric acid in the blood, and to its subsequent deposition in the tissues of the body."

Of the chemical changes produced in the blood by *fevers* very little need be now said. The author gives us all the latest facts, which vary but little from what is already known. He remarks that "though there can hardly be any doubt that all zymotic diseases are produced by certain germs or elementary organisms, yet there are only two diseases in which the presence of such germs in the blood has been clearly demonstrated, in relapsing fever and splenic fever (of cattle)." Several figures of the "spirillum" of relapsing fever are given, showing these organisms to consist of slender spiral filaments. They exist in the blood of the patients, but not in their organs after death. "They are found in the blood only during the paroxysmal attack; they are absent in the interval, and reappear several hours after the second attack has set in." By inoculation, they are capable of imparting the disease to a healthy person.

The natural history of the *splenic fever of cattle* is interesting, but space will only permit us to remark that in the blood of the animal the bacterian termed *Bacillus anthracis* has been found; to which the propagation of the disease is owing.

In this connection it is only proper to remark that in certain contagious and infectious diseases, the presence of germs in the blood has been remarked; as bacteria and micrococci in the blood of pyæmia, septicæmia, scarlatina, and diphtheria. Likewise certain parasitic organisms have been detected in the blood in some diseases endemic in Egypt and India; in which also the ova and embryos have been recognized in the urine.

In malarial fevers there appears to be no notable chemical alteration of the blood, until, in the advance of the disease, anæmia sets in. The author alludes to the recent discovery of Klebs and Tommasi Crudeli of a bacillus growing in the soil of malarial districts, to which they have given the name of *B. malariæ*, "which when introduced into the system of rabbits induces fever of an intermittent type." No mention however is made of the experimental researches of our own countryman, Dr. Salisbury, who, many years ago, published the results of his investigations upon this subject in this Journal. It is also stated that about a year ago "Marchiafava has, in three fatal cases of pernicious malarial fever, succeeded in discovering in the splenic pulp in the blood, and in the marrow of the bones, spores and filaments of *B. malariæ*."

In *scarlatina*, *measles*, *smallpox*, and *erysipelas*, there are no characteristic chemical alterations of the blood. In *cholera*, as we all know, the blood has been carefully examined, and the results noted. The reader need only be reminded of its extreme viscidity, owing to the osmotic transudation of the watery portions into the intestines. There is also a considerable increase of *urea* in the blood of cholera, with a loss of its saline constituents.

Only one other disease can now be alluded to, viz., *Bright's disease of the kidney*. As is well known, the most important chemical changes in the blood, in this affection, consist in the diminution of the albumin and the increase of the urea. As regards the convulsions and coma which are usually considered as being occasioned by the action of the urea upon the great nerve centres, the author does not deem this explanation as sufficient: "The condition of uræmia is one which depends on many factors. Before the condition of uræmia is induced, the blood has usually become rich in water, poor in albumin, poor in corpuscles; and that in addition to an accumulation of urea and uric acid, it probably contains an excess of other proximate principles which may exert a specially poisonous action."

Passing by the chapter which contains a detailed description of the most approved methods of separating the different constituents of blood in health and diseases, together with figures of the apparatus required (some of which are sufficiently complicated), we come to Chapter V., which treats of "Lymph and Chyle, together with transudations normal and pathological." After describing the difference between chyle and lymph, and postponing the consideration of the former to Volume II., the author gives us the method of procuring fresh lymph from an animal, and then proceeds to describe its physical and chemical properties. Admitting the identity of the lymph-corpuscles and the white blood-corpuscles, he agrees with most modern authorities in ascribing their origin chiefly, though not exclusively, to the lymphatic glands; since "wherever lymphoid or adenoid connective tissue exists, as for instance in the mucous membrane of the stomach, and in the follicles of the thymus, of the tonsils, and of the spleen, there is doubtless a formation of lymph-cells."

The proteids of lymph are essentially the same as those of blood, although the proportions of some of these are very different; thus the fibrin of lymph exists in the proportion of 0.4 to 0.8 parts in 1000; the amount of serum-albumin varies between 21 and 60 parts in 1000. Sugar and urea are found in about the same quantities as in blood. Lactic acid, leucine and tyrosine have also been discovered. The salts are similar to those of the blood. The gases consist of carbonic acid, nitrogen, and a trace of oxygen.

The *liquids found in healthy serous sacs*, as the pericardium, peritoneum, and thorax, resemble true lymph in every respect. There is an exception however in the case of the *synovia*, which contains a larger proportion of solids than is found in the fluid of serous sacs, and is "specially distinguished from them by containing *mucin*."

The effused *liquids of dropsies* are not always identical in chemical composition, but vary in different situations even of the same body, "in consequence of local peculiarities." This difference in composition is illustrated by several analyses, given by the author, of the fluids taken from the pleura, peritoneum, sub-arachoid and that of œdema of the feet, —the solid matters varying from 11.30 (œdema) to 36.05 parts (pleura) in 1000 in one case; and in another from 17.83 (œdema) to 42.41 parts (pleura). The variation of the albumin is even yet greater. Dropsical fluids sometimes contain fibrin (as when they transude into an inflamed membrane); in other cases they contain only fibrinogen. They always coagulate, either spontaneously, or by aid of heat. They also contain both serum-albumin and serum-globulin; and the salines and extractives (urea and sugar) are found in about the same proportions as in the liquor sanguinis. The gases are carbonic acid, nitrogen and oxygen; though the latter is sometimes absent.

Chapter VI. is devoted to the physiology and chemistry of *pus*, and appears to have been very carefully worked up. The pus-globules "when first formed, resemble, if they are not identical with, the colourless cells of the blood;" when older, however, they present a more granular appearance, and exhibit several distinct nuclei. Pus-serum (liquor puris) resembles much the liquor sanguinis and the normal transudations; "it is doubtless, in great part, a transudation from the blood." It contains substantially the same proteids as the blood-serum, viz., serum-albumin and serum-globulin: the same is generally true also of the salines and extractives.

In the *cell-protoplasm of pus* three distinct proteids soluble in water exist, according to Miescher, which possess distinct chemical reactions.

Besides these, two others insoluble in water are present, one of which was formerly supposed to be identical with myosin. The *nuclei* of the pus-cell yield a peculiar insoluble body containing phosphorus to which Miescher has given the name of *nuclein;* the author, however, is somewhat doubtful of its existence as a definite body. The pus-cells contain an appreciable amount of *glycogen;* their chief *extractives* are cholesterin, fats and derivatives of glycerin-phosphoric acid. Their mineral constituents are principally sodium chloride and earthy phosphates. An interesting fact in relation to the blue colouring-matter which is occasionally formed in pus, and to which Fordos gave the name of *pyocyamin*, is that it has lately been shown by Fitz to be usually due to a species of bacterium, of the form of a *bacillus.*

In Chapter VII. we have an account of "The Connective Tissues." These include *connective tissue cells*, *white fibres of connective tissue* (tendons), *elastic fibres of connective tissue* (ligaments), and *ground substance of connective tissue.* With the histology of these structures we are not now specially concerned. The reader may perhaps be reminded that the white connective tissue, represented by *tendons*, yields the peculiar substance termed *collagen* (formerly collin), the characteristic of which is that it is converted into *gelatin* by the action of boiling water. The closely allied body *chondrin* is procured from cartilage, by long boiling in water under pressure. Both these substances are insoluble in cold water, alcohol, and ether. Both are soluble in boiling water, and their solutions, on cooling, *gelatinize* in a precisely similar manner. Their chemical differences are the following: Tannic acid precipitates gelatin even in very dilute solutions; its action on chondrin is much less marked. Gelatin is not precipitated by acetic acid, which throws down chondrin, the precipitate being soluble in an excess of the reagent. Chondrin is also precipitated by alum, acetate of lead, nitrate of silver, and sulphate of copper—which do not affect gelatin.

The *ground-substance or matrix* of the connective tissues is common to all the foregoing varieties of this tissue; it appears to be identical with the substance named *mucin*, which is the chief constituent of mucus, and is found also in epidermis, where it connects together the epithelial cells. It likewise constitutes a large portion of embryonic connective tissue. Mucin is a ropy, gelatinous substance, held in suspension by water, and soluble in very dilute hydrochloric acid. It is not affected by tannic acid, but is precipitated by lead acetate, though not by other mineral salts.

Certain late investigations render it probable that all the connective tissues possess common chemical properties; also, that chondrin is only a mixture of gelatin, mucin, and salts.

Under the head of "Osseous Tissues," a good description is given of the chemical composition of the bones of man and the various lower animals; and very full tables of their comparative analysis are added. As regards the chemical changes in diseased bones, a remark may be made on *rickets.* The author takes occasion, very properly we think, to criticize a modern theory which ascribes the production of this disorder mainly to the formation of lactic acid in the alimentary canal, and its subsequent absorption into the blood, and its then acting as a solvent on the calcareous salts. There is no established proof of this action of lactic acid, nor can it be supposed that the blood could possibly lose its normal alkalinity, as would obviously be the case if a *free* acid were present. Very full details are given for procuring the different constituents of bone, and determining their proportionate amounts.

We pass over Chapter VIII., which treats of the "Epithelial Tissues," as presenting nothing especially new, and therefore not requiring any present notice; and find in Chapter IX. an interesting account of the "Contractile Tissues," under which head the author discusses the structure and properties of the *striated and non-striated muscular fibres.* The anatomical and physiological, as well as the chemical description of these structures, is very complete and satisfactory.

The following bodies, among others, have been procured from living muscle, and their properties established: *Sarcolemma,* the delicate investment of muscle-fibre, is very analogous, in composition and properties, to elastic tissue. The *double-refracting* (*anisotropous*) *matter* of voluntary muscle is solid both during life and after death; it is probably a proteid derivative. The *muscle-plasma* is the isotropous liquid of voluntary muscle-fibre. It can only be obtained from perfectly fresh muscle before rigor mortis has set in. The muscle must be frozen, and then subjected to strong pressure, at a low temperature. It is in the form of a viscid liquid, which at ordinary temperatures coagulates spontaneously, precisely like liquor sanguinis. The solid body resulting from this coagulation is named *myosin.* It does not separate from blood-plasma in a very cold temperature. "It differs from fibrin in being a gelatinous mass from the first; it never becomes fibrous, nor has the opacity of blood fibrin."

The nitrogenous (non-proteid) bodies are *creatine, creatinine, xanthine, hypoxanthine* or *sarcine, inosinic acid,* and *taurin.* The non-nitrogenized matters include *fats, glycogen,* and *inosit.* The salts are chiefly potassium phosphate, with minute portions of sodium, calcium, and magnesium phosphates, together with traces of chlorine and iron.

The most interesting and important phenomenon of muscular life is its *contractility,* including the *rigor mortis.* "The whole phenomenon of contraction comprises (1) a sudden acceleration and extension of chemical decomposition; and (2), a sudden and extensive conversion of the potential energy of chemical affinity into actual energy of various forms." These forms are those of heat, electrical disturbance, and mechanical motion. The visible *manner* in which the muscle-fibres contract, as seen under the microscope, need not be referred to here, as it is fully explained in all modern works on physiology. Neither may we be tempted to dilate upon the important relationship between the energy of muscular contraction and the amounts of heat, electricity, and mechanical power evolved.

The necessity for a due supply of oxygen to enable muscles to contract is shown by numerous experiments—directly, by the fact that an exhausted muscle can be made to recover its power by injecting into it arterialized blood, and *indirectly,* by the circumstance that the amount of carbonic acid excreted during muscular contraction very closely corresponds with the quantity of oxygen respired, and the amount of energy displayed.

As is well known, the *rigor mortis* is the last act of muscular life; after cadaveric rigor passes off, putrefaction immediately commences. Although, undoubtedly, closely allied to muscular contraction, it yet differs from it in certain particulars. "Rigid muscle is less extensile, as well as less elastic, than normal resting muscle, thus differing from contracted muscle, which is more extensile. It is further distinguished from contracted muscle by its peculiar doughiness and opacity." The author attempts no explanation of the cause of rigor mortis, other than that to which it is usual now to attribute it—the coagulation of the myosin. The evolution of heat which accompanies rigor mortis, together with the formation of lactic acid, and the elimination of carbonic acid, are circumstances which clearly demonstrate the analogy between ordinary muscular contraction and cadaveric rigidity. The evolution of heat just alluded to as accompanying the rigor mortis, termed *post-mortem caloricity*, may frequently escape observation; but under certain conditions, as after death from cholera, yellow fever, and other diseases, the temperature of the body has been known to rise nine to ten degrees beyond that existing during life.

The author devotes considerable space to describing the various chemical changes that result in the contraction of muscles, together with the proper methods of experimentation. One only will we here allude to, namely, the formation of *lactic acid*, which the latest investigations show not to pre-exist in living muscle (as was formerly supposed), but always in *dead* muscle, however fresh. Its amount, moreover, always increases in a tetanized (contracted) muscle in proportion to the resistance overcome; the same is also true in rigor mortis.

Finally, on this subject, we may very briefly allude to the excretion of urea by the kidneys as an index of muscular metamorphosis. Until very recently physiologists have believed that the amount of urea excreted by the kidney represented, with tolerable accuracy, the amount of nitrogenous disintegration caused by muscular action. A different view is now held by the latest experimenters. According to our author, "the urine, so far as it represents the tissue-waste of muscles, is dependent upon the nutritional rather than upon the functional processes of muscular tissue." While admitting, then, that muscular exercise does increase excretion of nitrogen products, we are not to forget that the nature of the food is an important factor in the result. Indeed, it would seem that very frequently the immediate effect of exercise is to diminish rather than to increase the quantity of urea, so that, in the opinion of Parkes, its elimination is greater during rest than during labour. Upon this interesting subject a great deal might profitably be said, if the limits of this article, already exceeded, permitted.

We must pass on to consider, very briefly, Chapter X., which contains a description of the "Nervous Tissues." With the histological elements of the nervous system we are not now concerned. As to their chemical composition we may observe that "more than one-half of the solids contained in the gray matter, and about one-fourth of the solids of the white matter of the nerve-centres, consist of proteid substances."

By treating gray nerve matter, and also the medullated nerve fibres, with boiling alcohol and ether, a basement substance is obtained, very refractory to chemical agents, named *neuro-keratin*, from its analogy with the keratin of the horny tissues. It contains 2.93 per cent. of sulphur.

The *phosphorized bodies* constitute the most important and interesting compounds of nerve substance. These were formerly grouped together under the name of *cerebrin* and *cerebric acid;* but the researches of Liebreich, in 1865, resulted in isolating a definite crystalline body, to which he gave the name of *protagon*.

The author, in repeating the experiments of Liebreich, feels convinced of the real existence of this body, to which he assigns the empirical formula of $C_{160}H_{308}N_5PO_{35}$. He regards it as the best characterized of all the phosphorized compounds yet obtained. Protagon undergoes various chemical transformations, through the agency of the acids and alkalies.

Another phosphorized compound found in nervous tissue, and also in the yolk of eggs, is *lecithin*, a yellowish-white, wax-like body, whose empirical formula is $C_{44}H_{90}NPO_9 + H_2O$. This substance, by decomposition, yields *glycerin-phosphoric acid*. The compound termed *neurine* (a term formerly employed to designate what was supposed to be the special material of nerve matter) is now procured as a distinct body, by the decomposition of protagon. It is a syrupy substance, alkaline in its reaction, soluble in alcohol and ether. It contains no phosphorus.

The non-phosphorized group also comprises *cerebrin*, a nitrogenized body, whose composition is not yet absolutely established; also the non-nitrogenized compound *cholesterin*, which exists in considerable amount in nervous tissues, especially in the white substance. The extractives of the brain consist of the same bodies as are found in muscle, viz., creatine, xanthine, hypoxanthine, inosit, and lactic acid, "with leucine, uric acid, and probably urea." As is well known, the proportion of *water* in the brain varies according to age, being much greater in infancy; it also differs in the white and gray matter, being considerably larger in the latter.

The importance of a full supply of oxygen to the cells of the gray matter, to enable the nerve-centres to maintain their functional activity, is witnessed by the effect produced upon the respiratory centre in the medulla, by the circulation of blood deficient in oxygen. The same is true of the mental operations; the moment the supply of oxygenated blood is cut off from the brain by compression of the large arteries, as in strangulation, all mental acts cease. It is well known that unconsciousness supervenes, in hanging and strangling, some time before life ceases.

In connection with the nervous tissues, the author discusses the "chemical history of the peripheral terminations of the nervous system, particularly those of the eye." Although this is a subject of profound interest to the student, and one offering a very tempting field for discussion, we are now compelled, reluctantly, to pass it over.

From our careful, though at times necessarily cursory, analysis of Dr. Gamgee's new work, our readers will readily conclude that we have a high appreciation of it. It is written in a very pleasing, unpretentious style, which we deem a great merit in a scientific book. It may be considered as the most reliable modern authority in Physiological Chemistry. We shall hail with much pleasure the advent of the second volume.

J. J. R.

ART. XXIV.—*Health Reports.*

1. *First Annual Report of the State Board of Health, Lunacy, and Charity of Massachusetts*, 1879. *Supplement containing Report and Papers on Public Health.* 8vo. pp. 277. Boston, 1880.
2. *Circular No.* 3, *of the Board of Health of the State of Alabama.* 8vo. pp. 206. Montgomery, May 1, 1880.
3. *Report on Yellow Fever in the U. S. S. Plymouth in* 1878–9. Prepared under the direction of PHILIP S. WALES, Surgeon-General U. S. Navy. 8vo. pp. 85. Washington, 1880.

1. THE successor to the valuable series of Reports of the Health Board of Massachusetts fully sustains their wide-spread reputation, and contributes numerous important facts and deductions to the general fund of knowledge held in common by sanitary scientists. Several contributions, such as that of the Secretary "On the Westfield River Basin," the admirable paper